April 2, 1968 MASANORI FUJIMURA ETAL 3,375,774

FULLY AUTOMATIC ELECTRIC COFFEE POT

Filed Jan. 5, 1967 5 Sheets-Sheet 1

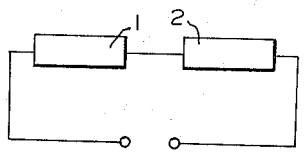


FIG.1

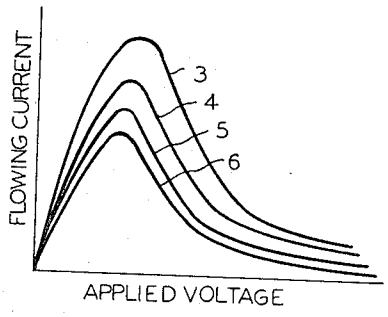


FIG.2

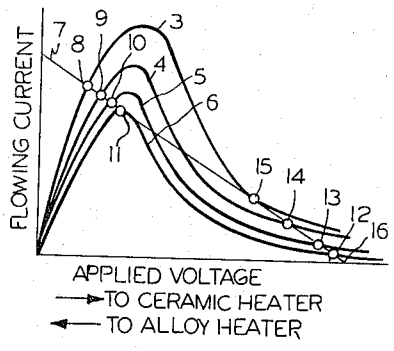


FIG.3

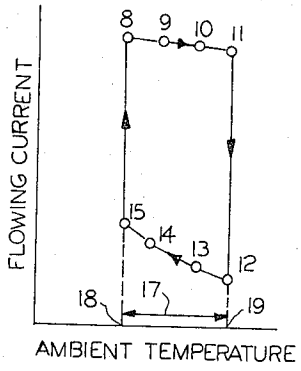


FIG.4

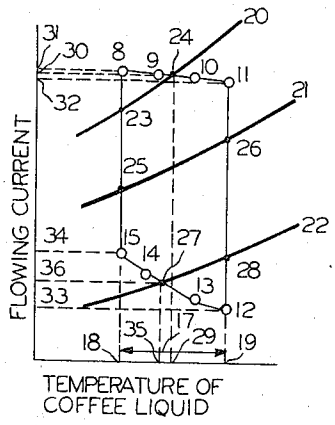


FIG.5

M.FUJIMURA
Y. KASAHARA
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FULLY AUTOMATIC ELECTRIC COFFEE POT

Filed Jan. 5, 1967 5 Sheets-Sheet 2

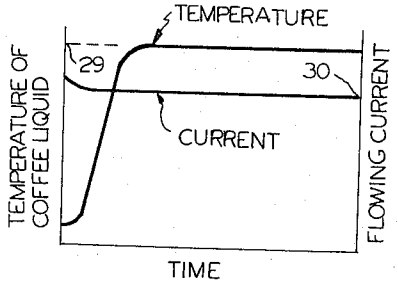


FIG.6

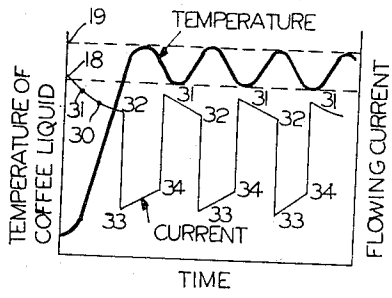


FIG.7

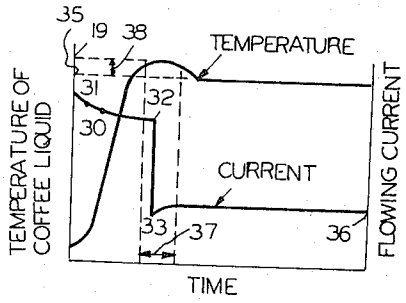


FIG.8

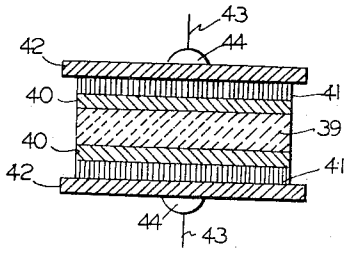


FIG.9

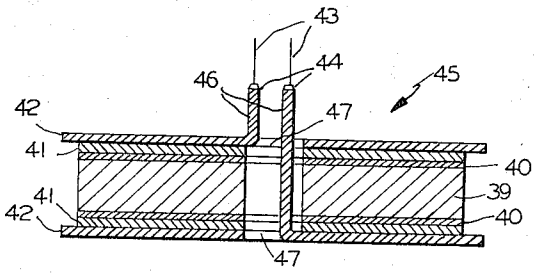


FIG.10

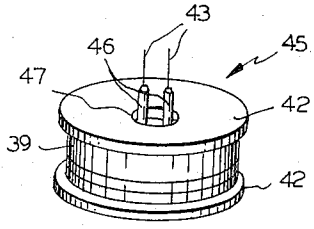


FIG.11

M. FUJIMURA
Y. KASAHARA
T. IGUCHI
Y. MATSUO
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K. NAGASE
S. HAYAKAWA
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FULLY AUTOMATIC ELECTRIC COFFEE POT

Filed Jan. 5, 1967 5 Sheets-Sheet 3

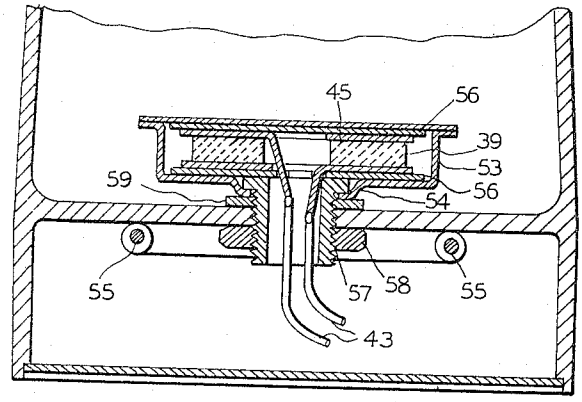


FIG.13

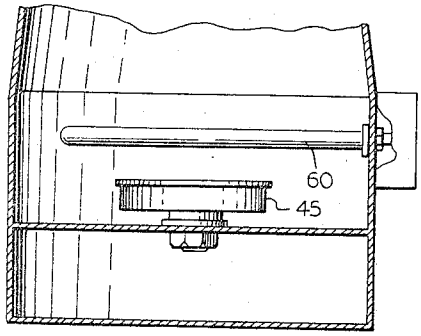


FIG.14

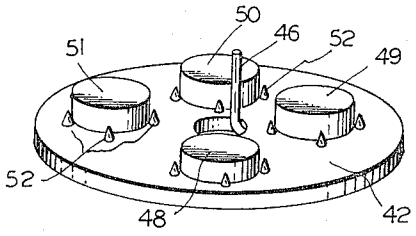


FIG.12

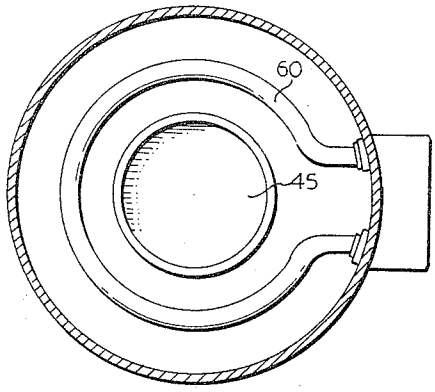


FIG.15

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FULLY AUTOMATIC ELECTRIC COFFEE POT

Filed Jan. 5, 1967 5 Sheets-Sheet 4

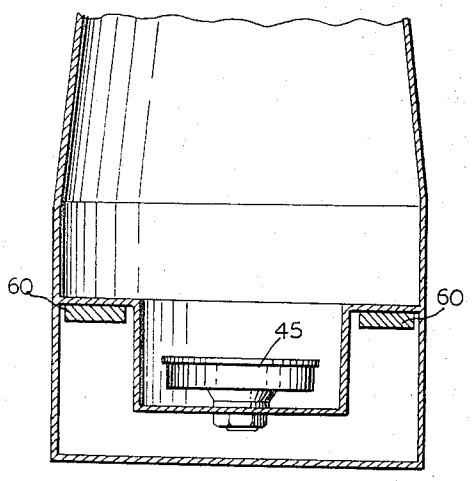


FIG. 16

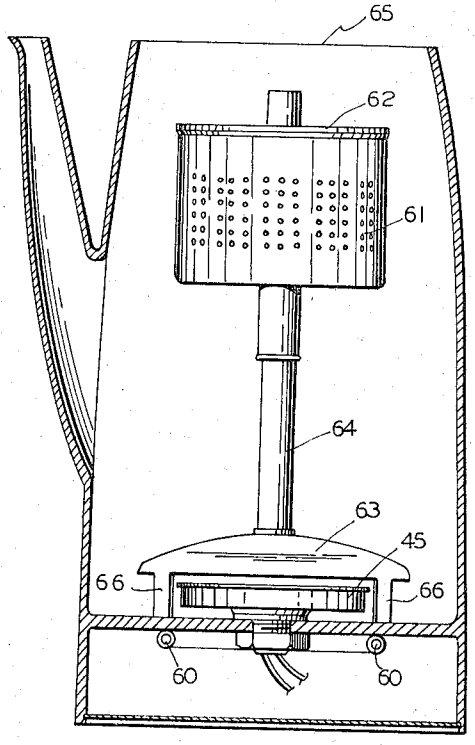


FIG. 18

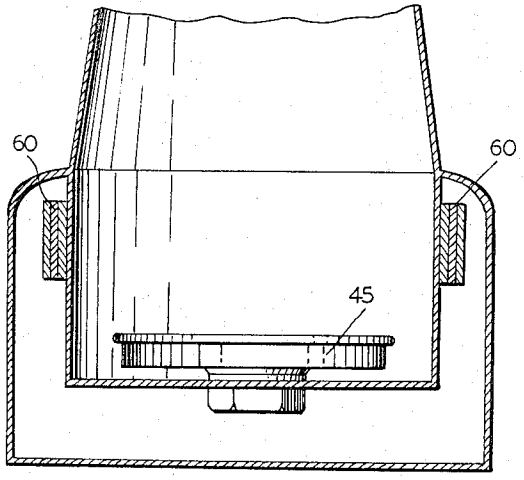


FIG. 17

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FULLY AUTOMATIC ELECTRIC COFFEE POT

Filed Jan. 5, 1967 5 Sheets-Sheet 5

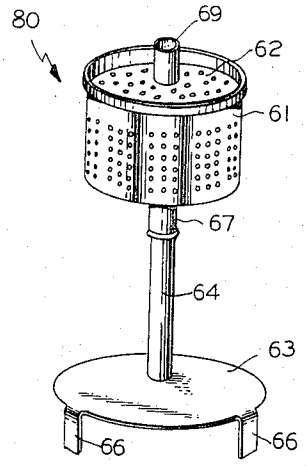


FIG. 19

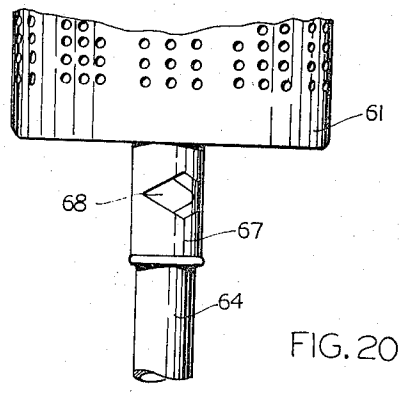


FIG. 20

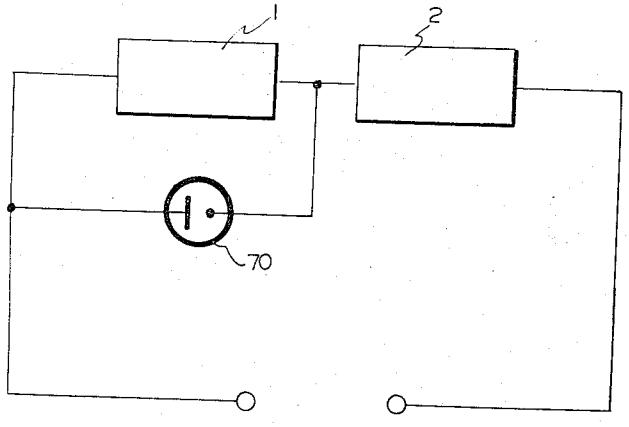


FIG. 21

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United States Patent Office 3,375,774 Patented Apr. 2, 1968

3,375,774

FULLY AUTOMATIC ELECTRIC COFFEE POT

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Filed Jan. 5, 1967, Ser. No. 607,421
9 Claims. (Cl. 99—281)

ABSTRACT OF THE DISCLOSURE

An automatic electric coffee pot having a heating unit consisting of a conventional alloy resistance heater connected in series with a positive temperature coefficient of resistance ceramic heater made of barium titanate semi-conductor, the circuit of the heating unit first causing the liquid to be heated to boiling to brew the coffee, and then the resistance of the ceramic heater abruptly rising to reduce the current flow and the temperature of the heating unit so as to keep the brewed coffee warm without further boiling.

Background of the invention—field of invention

This invention relates to an electric coffee pot capable of automatic operation, and more particularly to an electric coffee pot the heating system of which comprises a metal alloy heater and ceramic heater the electrical resistance of which rises abruptly at a certain temperature.

Description of the prior art

Conventional automatic coffee pots keep the temperature of the liquid coffee at a constant temperature after boiling by using a relay such as a bimetal switch. However, the contact of the relay is frequently apt to break down and to cause a failure in the operation of the coffee pot. Moreover, it is expensive to make an automatic coffee pot which is reliable in operation, because reliable operation requires a complicated electrical circuit and an expensive relay. The art has sought to make a fully automatic coffee pot which automatically boils the water for an initial period of time in order to prepare the coffee at a desired concentration, and subsequently keeps the prepared coffee warm at a desired temperature for a long time. Such a fully automatic coffee pot is very expensive when it is constructed in a conventional manner using complicated electrical circuit and controlling means.

Summary of the invention

An object of the invention is to provide an automatic coffee pot which has no relay contact.

Another object of the invention is to provide a fully automatic coffee pot which has no relay contact and which does not have a complicated electrical circuit.

The objects of the invention are realized by an automatic electric pot having a heating unit consisting of the ceramic heater mounted in the inside of a coffee container, and an alloy heater electrically connected in series with the ceramic heater and mounted on the coffee container for supplying heat to the liquid within the container. The ceramic heater is a semiconductive barium titanate ceramic which has an electrical resistance lower than that of the alloy heater at room temperature and rapidly increases in electrical resistance near the Curie temperature thereof. The voltage-current characteristics of the ceramic heater and the current flow-temperature characteristics of the coffee container when a given amount of liquid is contained therein cause an abrupt decrease in the current flowing through the heating system so as to keep the coffee warm at a given temperature after the coffee has been boiled for a pre-determined period of time.

Brief description of the drawings

The invention will be described in connection with the accompanying drawings in which:

FIG. 1 is a circuit diagram of the temperature sensitive heating system of the present invention;

FIG. 2 is a graph showing the characteristic current vs. voltage curves of the ceramic heater of the invention operating at several ambient temperatures;

FIG. 3 is a graph showing the various operating points of the heating system at various temperatures;

FIG. 4 is a graph showing the variation of current with variation of the ambient temperature of the ceramic heater of the heating system according to the present invention;

FIG. 5 is a graph showing a temperature cycle as shown in FIG. 4 and thermal characteristic curves of three typical coffee pots;

FIG. 6 is a graph showing a time-temperature curve of liquid coffee and a time-current flow curve of a coffee pot having the thermal characteristic curve **20** shown in FIG. 5;

FIG. 7 is a graph showing time-temperature curve of liquid coffee and a time-current flow curve of a coffee pot having the thermal characteristic curve **21** shown in FIG. 5;

FIG. 8 is a graph showing a time-temperature curve of liquid coffee and a time-current flow curve of a coffee pot having the thermal characteristic curve **22** shown in FIG. 5;

FIG. 9 is a cross sectional view of a ceramic heater comprising a semiconductive barium titanate ceramic disc having a large positive temperature coefficient of electrical resistance;

FIG. 10 is a cross sectional view of a ceramic heater according to the present invention having a hole at the center;

FIG. 11 is a perspective view of the ceramic heater shown in FIG. 10;

FIG. 12 is a perspective view of a ceramic heater comprising the plurality of positive temperature coefficient of resistance ceramic discs and a pair of metal plates having projections thereon for holding the plurality of ceramic discs with the upper metal plate omitted to better illustrate the construction of the heater;

FIG. 13 is a cross sectional view of a ceramic heater mounted in the interior of the bottom of a coffee pot;

FIG. 14 is a cross sectional view of a coffee pot having an alloy heater at a position higher than that of the ceramic heater;

FIG. 15 is a transverse sectional view of the coffee pot shown in FIG. 14;

FIG. 16 is a cross sectional view of a coffee pot having a recess in the bottom for mounting a ceramic heater;

FIG. 17 is a cross sectional view of a coffee pot having an alloy heater mounted externally thereof at a position higher than that of a ceramic heater mounted in the bottom;

FIG. 18 is a cross sectional view of an entire coffee pot according to the invention;

FIG. 19 is a perspective view of the basket and stem of the coffee pot of FIG. 18;

FIG. 20 is a side elevation view of a part of a basket and a stem having a hole for controlling the amount of water vapor to be condensed for extracting coffee; and

FIG. 21 is an electrical circuit diagram of an indicating lamp for indicating the operation of the coffee pot according to the invention.

Description of preferred embodiments

Before proceeding to a detailed description of the construction of the automatic coffee pot according to the invention, the novel heating system will be explained with reference to FIGS. 1–4 of the drawings.

Referring to FIG. 1, terminals adapted to be electrically connected to current source are connected to a ceramic heater **1** and to an alloy heater **2**, the ceramic heater **1** and the alloy heater **2** being connected in series with each other. Said alloy heater **2** is made of a conventional alloy resistor such as a Ni-Cr alloy resistor. Said ceramic resistor **1** is made of a so-called positive temperature coefficient of resistance (hereinafter abbreviated to PTC) barium titanate ceramic body which has a lower electrical resistance than that of the alloy heater at room temperature and abruptly increases its electrical resistance above a certain temperature. Such resistors are disclosed in the prior literature (e.g. U.S. Pats. 3,044.968 and 2,981,699).

Referring to FIG. 2, reference characters **3**, **4**, **5** and **6** designate the characteristic voltage-current curves for said ceramic heater with respect to various ambient temperatures thereof. The ambient temperature increases in the order of curves **3**, **4**, **5** and **6**. A current flowing through the ceramic heater increases with an increase in the applied voltage and there is an accompanying increase in the temperature of the ceramic heater itself. When the temperature exceeds a specified temperature, which depends upon the PTC characteristics of the ceramic heater, the current flowing through the ceramic heater decreases even with increasing applied voltage because of the PTC characteristics. The characteristic voltage-current curves for the ambient temperatures of the ceramic heater curve upwards at a lower applied voltage and then downwards at a higher voltage as shown in FIG. 2. When the ambient temperature is higher, a specified temperature is achieved by a lower applied voltage. Therefore, the characteristic voltage-current curves of the ceramic heater shift down with an increase in the ambient temperature, as shown in FIG. 2.

FIG. 3 shows the operating points of the present novel heating system comprising said ceramic heater and alloy heater when a voltage **16** is applied to the heating system. The voltage current curves of the ceramic heater are designated by the same reference numbers as in FIG. 2. The load line of said alloy heater is represented by the reference character **7**. As a practical matter, the load line varies slightly with the ambient temperature. However, the variation is negligible when compared with that of the ceramic heater. An operating point is defined by the intersection of a voltage-current curve of said ceramic heater with the load line of said alloy heater. The operating point can be determined by current flowing in the heating system and the voltages divided between the ceramic heater and the alloy heater. Since the voltage-current curves of said ceramic heater vary in the order **3**, **4**, **5** and **6** with increasing ambient temperature, the operating point also varies successively in the order **8**, **9**, **10** and **11** while there is an accompanying decrease of the current flow as shown in FIG. 3 in accordance with the invention. Since the characteristic curve **6** is tangent to the load line at the point **11**, the operating point immediately moves from the point **11** to the point **12** as soon as the ambient temperature exceeds the temperature for the characteristic curve **6**. Consequently, the current flow drops abruptly. The abrupt decrease in the current flow results in a decrease in the amount of heat radiated from the heating system. As the temperature goes down, the operating points move successively in the order **12**, **13**, **14** and **15** along the load line **7** while there is an accompanying increase of the current flow. Since the characteristic curve **3** is tangent to the load line at the point **15** as shown in FIG. 3, the operating point immediately moves from the point **15** to another operating point **8** with a further decrease in the ambient temperature. Thus, the flowing current and amount of heat radiating from the heating system increases abruptly.

The ambient temperatures for the curve **3** and the curve **6** are respectively the lower limit and upper limit of the working temperature range of the present novel heating system. FIG. 4 shows the relation between the ambient temperature of the ceramic heater and current flowing in the heating system according to the invention. The operating points of the curve in FIG. 4 correspond to those in FIG. 3 and they are designated by the same numbers. The working temperature range of the present heating system is designated by **17** and its lower limit and upper limit are represented by the points **18** and **19**, respectively. As the ambient temperature of the ceramic heater rises from the lower limit **18**, the current flow decreases gradually in the order **8**, **9**, **10** and **11**. When the ambient temperature of the ceramic heater reaches the upper limit **19**, the current flow drops abruptly from the point **11** to the point **12**. This abrupt decrease of the current lowers the ambient temperature of the ceramic heater. As the temperature goes down, the current flow gradually increases in the order **12**, **13**, **14** and **15**. When the temperature falls to the lower limit **18**, the current flow increases abruptly. Thus, the ambient temperature of the ceramic heater moves through a temperature cycle as shown in FIG. 4 according to the action of the present novel heating system. The lower limit **18** and the upper limit **19** can be predetermined by the thermal characteristics of the ceramic heater and the alloy heater.

The present novel heating system can be used as the heater for a coffee pot. The ambient temperature of the ceramic heater corresponds to the temperature of liquid coffee in the coffee pot.

Referring to FIG. 5, the equilibrium temperature-current characteristics of three coffee pots with respect to their heat capacity are graphically represented by the curves **20**, **21** and **22**. The temperature cycle of the present novel heating system is also given. The curve **20** intersects the temperature cycle at the points **23** and **24**, the curve **21** at points **25** and **26**, and the curve **22** at points **27** and **28**. The temperature of the liquid coffee in the coffee pot having the characteristic curve **20** reaches a thermal equilibrium at the temperature **29** and at the current flow **30**. In the coffee pot having the characteristic curve **21** the temperature of the liquid fluctuates between the two temperatures **18** and **19** in such a way that the operating point repeatedly moves along the temperature cycle curve from **8** through **11**, **12** and **15** back to **8**. The temperature of the liquid coffee in the coffee pot having the characteristic curve **22** goes through the temperature **19** and reaches a thermal equilibrium at the temperature **35** and at the current flow **36**.

Variations of temperature and current with the passage of time in these three typical coffee pots can be graphically represented as shown in FIGS. 6, 7, and 8, respectively, wherein the reference numbers are the same as those in FIG. 4. Among the three typical coffee pots mentioned above, the pot having the characteristic curve **22** is most desirable for practical use because of the following reasons. Referring to FIG. 8, the temperature of coffee liquid goes up to the maximum temperature **19** during the current flow **31**, **30** and **32** and then decreases slowly with an abrupt decrease in the current flow from **32** to **33** in accordance with the invention. Then the current reaches an equilibrium value **36** and the temperature of coffee liquid is in equilibrium at the temperature designated by the reference number **35** in FIG. 8. The coffee liquid is slowly cooled from the temperature **19** and is kept at the temperature higher than the temperature **35** for a certain time interval **37**. Since the temperature **19** can be controlled to be 100° C. by selecting appropriate heating power and heat capacity of the coffee pot, coffee can be extracted by the boiling water during the time interval **37**. The warming temperature **35** can also be con-

trolled to be any suitable temperature for drinking by selecting appropriate heat capacity and electrical resistance of ceramic heater and alloy heater in connection with their relative location described hereinafter.

A coffee pot having the novel heating system can automatically control the temperature of a given amount of liquid coffee in such a way that the water is heated up to the boiling point, kept at the boiling temperature for a certain time interval to produce liquid coffee of a desired concentration, and then the coffee liquid is kept warm at a desired temperature for a long time without further boiling.

A novel heating system according to the invention comprises a ceramic heater mounted in the inside of coffee pot and a conventional alloy heater connected in series with the ceramic heater. The electrical resistance of the ceramic heater is very much lower than that of the alloy heater at a room temperature of 10° C. to 30° C. and becomes very much higher that that of the alloy heater above the temperature at which the coffee liquid boils or is kept warm. The alloy heater and ceramic heater are selected so as to produce an alloy heater ceramic resistance ratio of from 500:1 to 2:1 at room temperature, and a ratio of from 1:500 to 1:2 after the liquid coffee has been heated up to a boiling temperature. In this heating system, the alloy heater is the main heat source until boiling occurs, whereas the ceramic heater is the main source of heat for warming after the boiling. After the boiling, the liquid coffee is kept warm at a certain temperature mainly by the heat radiated from the ceramic heater.

The ceramic heater can be made of any barium titanate ceramic having an abrupt increase in electrical resistance above a certain temperature. The barium titanate ceramic can be prepared by well known ceramic techniques. For example, 66.26 to 71.00% by weight of $BaCO_3$, 28.16 to 28.80% by weight of TiO_2, 0.10~2.79 percent by weight of Al_2O_3, and 0.10~2.79% by weight of SiO_2 are wet-milled for mixing. The resultant mixture is pressed into a disc of the desired form and fired in air at 1350° C. for 2 hours. The sintered disc is provided with electrodes on opposite surfaces by any available method. Preferred electrodes for a ceramic are silver electrodes made by painting silver paste on opposite surfaces of the disc and firing in a nitrogen atmosphere, or a nickel-phosphor alloy electrode made by electroless plating.

The produced disc has metal plates secured to the opposite surfaces by any appropriate means, such as soldering. Such a disc is shown in FIG. 9, in which is shown a barium titanate ceramic disc **39** provided with electrodes **40** on the opposite surfaces thereof and in which solder **41** is used for electrically connecting the disc **39** to metal plates **42**. A lead wire **43** is electrically connected to the metal plate **42** by means of a solder **44**. The solders **41** and **44** are required to have a melting point higher than the operating temperature of the ceramic heater. Said metal plates can be made of any metal or alloy such as nickel, copper, iron, nickel alloys, copper alloys and iron alloys.

It has been discovered according to the invention that the disc **39** and metal plates **42** can be holed as shown in FIGS. 10 and 11. Reference character **45** represents, as a whole, a novel ceramic heater according to the invention. The metal plates **42** are holed and a thin strip **46** is left for ease in connecting the lead wire **43** to the plate **42**. The strip **46** is bent upwardly at the circumference of hole **47**. The metal plates are assembled so that the strip **46** on the lower metal plate projects through the hole **47** in the upper plate, as shown in FIGS. 10 and 11. This arrangement facilitates easy electrical connection to an outside electrical source when the ceramic heater is attached to the coffee pot.

It has been found that the ceramic heater comprising a plurality of barium titanate ceramic discs achieves a more efficient heat radiation than a single barium titanate ceramic disc does. In addition, the temperature program

i.e. the time interval during which boiling occurs designated by reference number **37** in FIG. 8 and the temperature difference **38** between the boiling temperature and the warming temperature can be controlled by using PTC barium titanate ceramics having different Curie temperatures at which the electrical resistance abruptly rises.

Referring to FIG. 12, reference character **42** designates the same metal plate as shown in FIGS. 9, 10 and 11 and 46 designates the thin strip for completing an electrical connection. The metal plate **42** is adhered to the PTC barium titanate discs **48**, **49**, **50** and **51** all of which are of equal thickness. The PTC disc **48** has a different Curie temperature from other discs **49**, **50** and **51**. The difference is required to be from 50° to 100° C. For example, the ceramic disc **48** has a Curie temperature of 80° C. and the other discs **49**, **50** and **51** have a Curie temperature of 150° C. at which their electrical resistance rises sharply. The number of discs need not be limited to four as indicated in FIG. 11; any number can be used. The plurality of PTC barium titanate ceramic discs can be held at predetermined positions by using metal plates having small projections **52** on the surface as shown in FIG. 12. The discs **48**, **49**, **50** and **51** are placed among the projections **52** and soldered to the metal plate **42** by a solder. The projections **52** on the lower plate **42** are operable to hold the discs by themselves, but it is preferable that both metal plates be provided with the projections **52**. The projections **52** can be made by any available method such as adhering small nails of metal to the metal plate **42** by soldering. The height of projections **52** is necessarily less than the thickness of the discs **48**, **49**, **50** and **51** if the projections **52** are attached to only the lower metal plates **42**. When both metal plates are provided with the projections **52**, the height of projections **52** must be less than half the thickness of the discs.

The resultant ceramic heater is encased in a metal case and is mounted in the bottom of a coffee pot. Referring to FIG. 13, reference character **39** designates a ceramic heater like that shown in FIGS. 10 and 11 and **53** is a metal case containing the heater and having a cover in water-tight engagement thereon and secured by any available method such as soldering or seaming. The metal case **53** is spaced from the bottom face of the coffee pot as shown by a projection **54** in order to insure that the ceramic heater **45** is only very slightly affected by the heat developed in the alloy heater **55**. The ceramic heater **39** is electrically insulated from its metal case **53** by any conventional material, such as mica plates **56**. The projection **54** is connected to a screw **57** having a hole therein. Lead wires **43** having electrical insulation thereon extend through the hole to an external electrical source. The metal case **53** containing the ceramic heater **39** therein is tightly secured to the bottom of the coffee pot by a nut **58**. A rubber ring **59** is inserted between the bottom of the coffee pot and the projection **54** in order to prevent water leakage and to reduce heat transfer to the ceramic heater from the alloy heater. An alloy heater **55** having any conventional construction is attached to the outside surface of the bottom of the coffee pot and is electrically insulated from the pot by any conventional means. A convenient alloy heater is one in which the alloy heating element is in the form of a thin plate and is embedded in a mica plate. The alloy heater **55** is electrically connected in series with the ceramic heater **39** in a conventional manner and is coupled to a terminal of an electrical source (not shown).

While the alloy heater **55** can be positioned in any convenient location to produce the novel coffee pot, it has been discovered according to the invention that a more stable operation of the coffee pot can be accomplished by locating the alloy heater at a level above the ceramic heater in the coffee pot. When the alloy heater is located above the ceramic heater it does not thermally affect the ceramic heater because the hot water heated by the alloy heater does not readily circulate in the space

below the level of the alloy heater until turbulent circulation due to boiling develops. Therefore the ambient temperature of the ceramic heater remains at a lower temperature than the temperature of alloy heater located at the level above the ceramic heater until the water boils, and then it jumps to a higher temperature due to contact with the boiling water. The warming temperature is determined mainly by the heat capacity of the ceramic heater. Thus a decrease in heat energy transferred to the ceramic heater from the alloy heater results in an increase in the temperature difference designated by reference number **38** (FIG. 8) and a decrease in the time interval disignated by **37** (FIG. 8). FIGS. 14 and 15 show one embodiment in which a ceramic heater **45** is attached to the bottom of the coffee pot in the arrangement described above and an alloy heater **60** covered by a metal case is located at a level above the ceramic heater and the heaters are electrically connected in series. A preferred construction of the alloy heater according to the invention is one in which an alloy heating element is embedded in a metal pipe and is electrically insulated therefrom by an insulating material such as ceramic powder or glass fiber.

FIG. 16 shows another arrangement such as described above, and in which reference character **60** designates an alloy heater in a pipe and **45** is a ceramic heater which is electrically connected in series to the alloy heater **60**. The coffee pot has a depression in the bottom thereof formed by a downward projection of the bottom. The ceramic heater **45** is mounted in the depression so as to lessen the thermal effect of alloy heater **60**. It is necessary that the upper surface of ceramic heater **45** be lower than the inside surface of the bottom of the coffee pot which is contacted by the alloy heater **60**.

Another good arrangement of a ceramic heater and an alloy heater is the construction shown in FIG. 17, wherein the alloy heater **60** is attached to the external surface of the side wall of the coffee pot at a position higher than the bottom surface of the pot, and a ceramic heater **45** is mounted at the bottom surface by a construction illustrated above in FIG. 13. The alloy heater **60** is electrically connected in series with the ceramic heater **45** and is coupled to the terminals of an electrical source by means not shown. In this construction, the alloy heater is preferably in the form of a belt such as a Nichrome strip (Ni-Cr alloy) sandwiched between two flexible asbestos plates. An alloy heater having a pipe construction as described above also can be used in this arrangement.

It is important that hot liquid coffee in the pot circulate freely around the ceramic heater **45** which also plays the role of a temperature sensitive switch. Therefore, it is necessary that nothing prevent the circulation of hot liquid coffee around the ceramic heater. For this reason, the coffee basket and stem are required to have a specific construction.

Referring to FIGS. 18 and 19, reference character **80** designates, as a whole, a coffee basket and stem arrangement comprising the coffee basket **61** covered by a perforated cover **62** and a stem support **63** having the three legs **66**. Liquid and vapor come up through the stem **64** and the vapor condenses on the cover **65** and the liquid falls on the perforated cover **62** so as to extract coffee. The ceramic heater **45** has the three legs **66** spaced thereabout and is contacted by the freely circulating hot liquid coffee. This coffee basket and stem arrangement permits the ceramic heater to operate satisfactorily as a temperature sensitive switch.

The concentration of the liquid coffee is dependent upon the amount of coffee in the aforesaid coffee basket **61** and the boiling period for each given amount of water. A given construction of the automatic coffee pot has a definite boiling period depending on the characteristics of the above described heating system. In order to prevent excessive extraction of coffee during the definite boiling period, the novel fully automatic coffee pot has a specific coffee basket and stem arrangement in accordance with the invention.

Referring to FIG. 20 wherein the same reference characters represent the same components as those in FIGS. 18 and 19, the coffee basket **61** has a downwardly projecting sleeve **67** fitting closely around the stem **64**. Both stem **64** and sleeve **67** are provided with an aperture at the same level which aperture together define a hole **68**. The area of the hole **68** is adjusted by a rotation of the coffee basket **61** relative to the stem **64**. When the hole **68** is completely closed by the projecting sleeve **67**, all of the water vapor and liquid comes out from the top **69** of the stem. When the hole **68** is completely open, all of the water vapor and liquid comes out of the hole **68** and does not go up to the top **69**. Adjustment of area of hole **68** permits control of the amount of water vapor and liquid available for extraction of coffee during a given boiling period and can control the concentration of the liquid coffee. It is necessary in order to prevent the water vapor and liquid from coming out of the top **69** that the maximum area of the hole **68** be of the magnitude of one half to two times the area of the opening at the top **69**. One can easily prepare coffee having the desired concentration and taste by adjusting the area of hole **68** and can keep the thus produced coffee warm for a long time in accordance with the novel operation of the present fully automatic coffee pot.

As described above, the novel heating system comprising a ceramic heater and an alloy heater according to the invention operates in such a way that the voltage applied to the heating system is divided between the alloy heater and the ceramic heater in the ratio of from 500:1 to 2:1 during the boiling period and then in a ratio of from 1:500 to 1:2 after the boiling period. This voltage change easily facilitates providing a lamp indicating that the coffee is being kept warm for drinking after boiling.

Referring to FIG. 21, reference character **1** designates a ceramic heater and **2** is an alloy heater which is connected in series with said ceramic heater **1**, these reference characters being the same numbers as in FIG. 1. A neon lamp **70** which operates above a certain voltage is connected in parallel with the ceramic heater **1**. When the voltage of the electric source is applied across the terminals, the voltage is divided into two parts, i.e. the voltage applied to the ceramic heater **1** and the voltage applied to alloy heater **2**. An extremely small voltage is supplied to the ceramic heater **1** because the ceramic heater has a resistance much lower than that of the alloy heater at lower temperatures. When the ambient temperature of the ceramic heater goes up due to the heat energy of the alloy heater and reaches a specific temperature, the ratio of electrical resistance of the ceramic heater **1** to alloy heater **2** becomes from 500:1 to 2:1. Therefore, the voltage applied across two ends of the ceramic heater **1** becomes sufficient to actuate the neon lamp **70** so that it lights. In such a way the neon lamp **70** can indicate the time at which the coffee is ready for drinking and is kept warm by the ceramic heater. The neon lamp **70** can be attached to the automatic coffee pot in any conventional and suitable manner.

What is claimed is:

1. An automatic electric coffee pot comprising a liquid coffee container, a heating system comsisting of a ceramic heater mounted in the inside of said coffee container and an alloy heater electrically connected in series with said ceramic heater and mounted on said coffee container for supplying heat to liquid within said container, said ceramic heater consisting of semiconductive barium titanate ceramic which has an electrical resistance lower than that of said alloy heater at room temperature and rapidly increases in electrical resistance near the Curie temperature thereof, the voltage-current characteristics of said ceramic heater and the current-flow-temperature characteristic of said coffee container for a given amount of liquid causing an abrupt decrease in the flowing current through said

heating system so as to keep the liquid coffee warm at a given temperature after the liquid coffee boils for a predetermined time period.

2. An automatic electric coffee pot as claimed in claim 1, wherein the ratio of the resistances of said alloy heater and said ceramic heater at room temperature is from 500:1 to 2:1 and the said electrical resistance ratio after the rapid increase of resistance of said ceramic heater is from 1:500 to 1:2.

3. An automatic electric coffee pot as claimed in claim 1, wherein said ceramic heater is a single body of barium titanate ceramic in the shape of a disc having a hole at the center thereof and has electrodes on the opposite surfaces thereof, and a metal plate having holes at the center over each electrode.

4. An automatic electric coffee pot as claimed in claim 1, wherein said ceramic heater is a plurality of discs of said barium titanate ceramic and two metal plates each having a hole therein and between which said discs are held.

5. An automatic electric coffee pot as claimed in claim 1, wherein said ceramic heater is mounted at the bottom of the interior of said coffee container and said alloy heater is at a level higher than that of said ceramic heater, so that the ambient temperature of said ceramic heater jumps to boiling temperature only when the coffee liquid boils.

6. An automatic electric coffee pot as claimed in claim 1, wherein said coffee container has a depression in the bottom surface thereof and said ceramic heater is mounted in the depression in the interior of said coffee container, and said alloy heater is attached to the exterior surface of the undepressed portion of the bottom of the coffee container.

7. An automatic electric coffee pot as claimed in claim 1, wherein said coffee pot includes a coffee basket and stem arrangement having a stem with a stem support having three legs supporting the stem spaced from the ceramic heater to facilitate smooth circulation of hot liquid coffee around said ceramic heater.

8. An automatic electric coffee pot as claimed in claim 1, wherein said coffee pot includes a coffee basket and stem arrangement, said stem having a hole therein and an outlet at the top through which liquid and water vapor are discharged, said coffee basket having a downwardly extending sleeve with a hole therein in register with said hole in said stem, the area of the opening defined by said holes being varied by rotating the coffee basket.

9. An automatic electric coffee pot as claimed in claim 1, and a neon lamp connected in parallel with said ceramic heater for indicating the time at which the coffee is kept warm after boiling.

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